small balls having a diameter of less than 1 mm, cells that normally only grow on a solid base in the form of a cell "meadow" can be multiplied on the surface of balls. Polystyrene balls are particularly suitable.

About 5 g of the balls/liter of nutrient medium is introduced into a fermenter. That quantity of balls provides a surface of up to 30,000 cm^2. Tests with non-diploid Psylla (plant lice) cells in a suspension culture with micro-carrier balls have resulting in cell population figures of 4×10^6/ml of culture broth. Because high cell populations can result from the use of micro-carriers, the oxygen consumption is correspondingly high. With the air bubble method of the prior art the increased oxygen requirement is much harder to satisfy than with the membrane oxygen diffusion method according to the invention. With the membrane method, the metabolism efficiency of cells growing on the micro-carrier balls is improved, resulting in faster and increased cell division. The cell population increases faster per unit of time so that fermenter preparations from micro-carrier cultures supply more cells.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. In a fermentation vessel for propagating animal cells in suspension cultures and monolayer cultures in which oxygen must be supplied to the cells in a liquid nutrient medium in the vessel for cell metabolism and multiplication, the improvement comprising a permeable membrane partially defining a chamber or volume in the fermentation vessel and made of a polymeric material on which the cells do not grow to a significant extent but through which oxygen can diffuse directly, without bubbling, into at least a 4 liter volume of the liquid nutrient medium containing the cells;

the membrane being of a size and shape so that a sufficient amount of oxygen is diffused into the liquid so as to enable cell propagation;

conduit means communicating with the chamber from outside the vessel for supplying oxygen to the chamber for diffusion through the membrane; and

mechanical liquid-agitation means located within the fermentation vessel.

2. An improved fermentation vessel according to claim 1 in which the polymeric material is silicone rubber or polytetrafluoroethylene.

3. An improved fermentation vessel according to claim 1 in which the membrane is a tube.

4. An improved fermentation vessel according to claim 3 in which the tube wall is about 0.6 to 1.2 mm thick.

5. An improved fermentation vessel according to claim 3 in which the tube is on a rigid support.

6. An improved fermentation vessel according to claim 5 in which the rigid support is a heat exchanger.

7. A method comprising growing animal cells in suspension cultures and monolayer cultures in a fermentation vessel containing at least a 4 liter volume of a liquid nutrient medium, and supplying the cells with oxygen through a permeable membrane partially defining a chamber or volume in the fermentation vessel and made of a polymeric material on which almost no cell growth takes place, so that the oxygen diffuses directly without bubbling into the liquid medium;

the oxygen being supplied to the chamber from outside the vessel; and

the membrane being of a size and shape so that a sufficient amount of oxygen is diffused into the liquid so as to enable cell propagation.

8. A method according to claim 7 in which the membrane is in the form of a tube.

9. A method according to claim 8 in which the tube has a wall thickness of about 0.6 to 1.2 mm.

10. A method according to claim 8 in which the tube is silicone rubber.

11. A method according to claim 7 in which the membrane is a tube spirally wound on a rigid support.

12. A method according to claim 11 in which the rigid support is a heat exchanger.

13. A method according to claim 7 in which the animal cells are from a non-vertebrate.

14. A method according to claim 13 in which the animal cells are insect cells.

15. A method according to claim 7 in which cell growth continues until cell multiplication increases the cell population to at least 20 times the cell population at the start of fermentation.

16. A method according to claim 7 in which the polymeric material is silicone rubber or polytetrafluoroethylene.

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